MULTIMEDIA UNIVERSITY

STUDENT ID NO

# MULTIMEDIA UNIVERSITY

# FINAL EXAMINATION

**TRIMESTER 2, 2017/2018**

## EEL4106 – HIGH VOLTAGE ENGINEERING
( LE )

9 MARCH 2018
9.00 a.m – 11.00 a.m
(2 Hours)

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**INSTRUCTIONS TO STUDENT**

1. This question paper consists of 4 pages including the cover page with 4 Questions only.
2. Answer **ALL** questions. The distribution of the marks for each question is given.
3. Please write all your answers in the Answer Booklet provided.

## Question 1

(a) Circuit is shown in Fig. Q1(a).

(i) Name the type of circuit. [1 mark]

(ii) What are the numbers for A and B of the capacitances in the figure? [1 mark]

(iii) If the capacitor $C_2$ is charged to 2 $V_{max}$, what is the maximum output voltage produced at $R_L$ (load resistances) [1 mark]

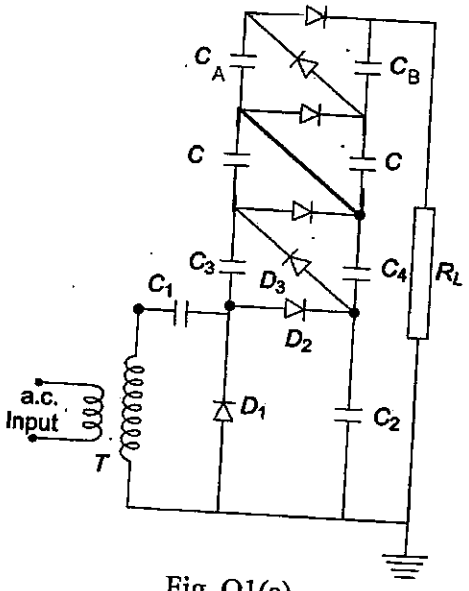


Fig. Q1(a)

(b) A 200 kVA, 400 V/400 kV feed transformer has resistance and reactance of 1% and 5% respectively. This transformer is used to test a cable at 800 kV at 50 Hz. The cable takes a charging current of 1.25 A at 800 kV. Determine the following:

(i) Series inductance required. [5 marks]

(ii) Assume 1% resistance of the inductor. Determine the input voltage to the transformer. Neglect dielectric loss of the cable. [4 marks]

(c) Give **THREE** comparisons on the characteristics of lightning and switching impulses. [3 marks]

(d) The elements of the circuit shown in Fig. Q1(d) for producing lightning impulse voltages are $C_1$ = 0.15 μF, $C_2$ = 1 nF, $R_1$ = 300 Ω, $R_2$ = 500 Ω. Compute an expression for the generated voltage if the charging voltage, $V_{charging}$ is 200 kV. (Hint: Generated voltage, $V = V_0\left[e^{(-\alpha t)} + e^{(-\beta t)}\right]$) [10 marks]

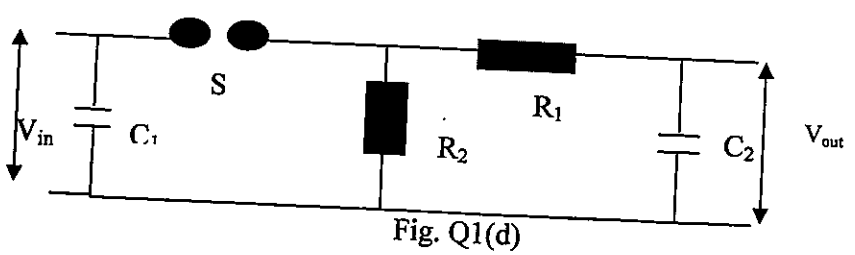


Fig. Q1(d)

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## Question 2

(a) Briefly describe **THREE** factors influencing measurements using the spark gap. [3 marks]

(b) Determine the breakdown voltage for uniform field gap with the air gap of length 2.5 mm under uniform field and standard atmospheric conditions. [3 marks]

(c) A generating voltmeter has to be designed so that it can have a range from 30 kV to 210 kV. If the indicating meter reads a minimum current of 3 μA and maximum current of 30 μA, what would be the capacitance of the generating voltmeter be? Assume that the driving motor is a synchronous motor with a speed of 1400 rpm. [5 marks]

(d) Define the following terms used in **IEC 60060-1:2010: High-voltage test techniques - Part 1: General definitions and test requirements.**

(i) Standards creepage distance
(ii) Disruptive discharge voltage
(iii) Flashover

[6 marks]

(e) There are two main tests that need to be conducted on surge diverters; high voltage and impulse current tests. Explain further on these **TWO** tests. [8 marks]

## Question 3

(a) List out **THREE** processes involved of breakdown in gases. [3 marks]

(b) Describe the phenomena of corona discharges in gas. [8 marks]

(c) Two of the important properties of liquid dielectric are high thermal stability and high viscosity. List out **THREE** other important properties of good liquid dielectrics. [3 marks]

(d) Practical solid insulating materials contain voids or cavities. The voids are usually filled with gases or liquids of lower dielectric strength than that of the solid. Because of this, under working stress of the insulation, the fields in the voids may exceed their breakdown value, thus causing breakdown of voids. A solid insulation with a cavity is shown in Fig. Q3(d).

(i) With a proper labelling, draw the equivalent circuit to represent the solid insulation and cavity [3 marks]

(ii) Prove that the voltage across the dielectric, V is

$$V = V_v\left[1+\frac{1}{\varepsilon_r}\left(\frac{d}{t}-1\right)\right]$$

where $V_v$ is the voltage across the void, d and t are as defined in Fig. Q3(d). [8 marks]

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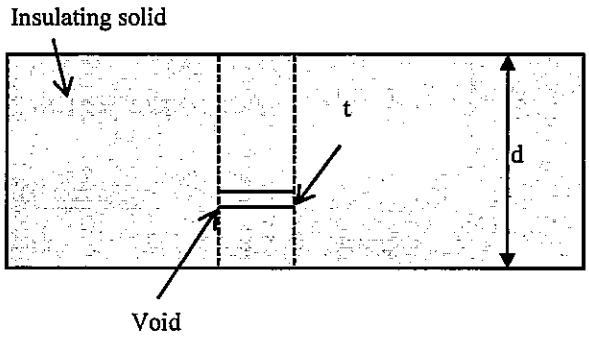


Fig. Q3(d)

**Question 4**

(a) List out **THREE** requirements of surge diverters. [6 marks]

(b) Draw and discuss the V-I characteristic curve of a surge arrester. [9 marks]

(c) A 500 kV, 2 μs rectangular surge on a line having surge impedance of 350 Ω approaches the terminal ending with a concentrated earth capacitance of 3000 pF. Determine the maximum value of the transmitted wave. [4 marks]

(d) A transmission line having a 450 Ω surge impedance is connected to a cable of 80 Ω surge impedance. When a surge voltage traveling along the transmission line meets the junction, the magnitude of transmitted wave to the cable becomes 300 kV. Calculate the magnitude of the incident surge and the voltage buildup at the junction with and without the cable connection. [6 marks]

**End of Paper.**